Maturation Of Instruments For Solar System Exploration

The Enceladus Organic Analyzer (EOA)

Completed Technology Project (2017 - 2020)

Project Introduction

Quantitative compositional and chiral organic molecule analysis is key to understanding an extraterrestrial location including its history, habitability and potential for past or present life. Few high-TRL instruments exist that can achieve this important goal. The advancement of the Enceladus Organic Analyzer (EOA) to TRL 6 will enable a powerful new approach for characterizing carbon chemistry in our solar system including the non-statistical distribution of organic molecules and optical isomers that tell us about the presence of extant or extinct life. EOA is an innovative microchip capillary electrophoresis (μCE) system with laser-induced fluorescence (LIF) detection. The μCE electrophoretically separates molecules with high resolution, and is very effective for analysis of organics having a wide range of sizes and complexity from a variety of solid, ice or liquid sources. The integrated Programmable Microfluidic Analyzer (PMA) enables reliable, flexible fluidic processing. LIF is highly sensitive with picomolar concentration limits of detection (the equivalent of only attomoles detected). EOA SCIENCE OBJECTIVES Detect and quantify amines, amino acids, carboxylic acids, and polycyclic aromatic hydrocarbons with parts-per-million sensitivity from samples as small as a few micrograms. Separate multiple (>20) amine-containing species (including amino acids) that differ in isomer or carbon chain-length with baseline resolution. Perform similar analyses on carboxylic acids and polycyclic aromatics. Separate chiral enantiomers of any observed amino acids. EOA MISSIONS Enceladus Plume Fly-By/Orbiter. The organic composition of the Enceladus plume is a high-priority science objective in the NASA Science Plan and the Decadal Survey prioritized an Enceladus orbiter. Comets. The EOA could be used to sample and analyze organics from comets and their coma that are beyond sample return to answer questions about primordial sources of organic matter and current synthesis. Icy Moon organic analysis. The core EOA analyzer instrument could also be deployed in orbiters, fly-by or lander missions that acquire solid/ice samples. TECHNICAL OBJECTIVES Raise TRL of the PMA. This technology is at a high TRL (5) having been extensively tested in lab and challenging field applications. Our objective is to fully demonstrate the PMA in a relevant environment as an integrated prototype raising TRL to 6. Raise TRL of LIF. LIF laser and optical detection systems have over a decade of development for space flight beginning with the Urey instrument for the ExoMars rover to the MOA instrument proposed for Mars 2020. This subsystem will be built and tested to elevate its TRL from 5 to 6. Raise TRL of the Capture Plate System from 3 to 6. When samples for the EOA are acquired from plumes or ejecta, a capture plate collects material during a fly by. An efficient soft impact capture has been developed that obviates the confounding problem of organic contamination found with other soft impact strategies like aerogels. Raise TRL of the integrated system including all peripheral hardware and control electronics. The TRL of most EOA components and subsystems is as high as 5. We will build and test an integrated technology demonstration unit with flight-like component subsystems raising the TRL of the whole instrument to 6. RELEVANCE The

The Enceladus Organic Analyzer

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

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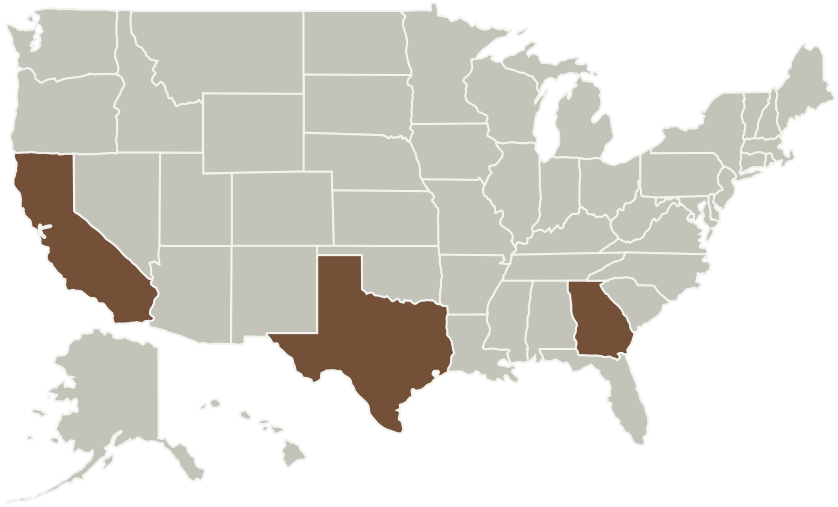
proposed work seeks to "develop and demonstrate" the EOA as a "planetary and astrobiology science instrument to the point where it may be proposed in response to future announcements of opportunity without additional extensive technology development (TRL 6)." The EOA is an "innovative technology that improves instrument measurement capabilities" in a "small, low mass, low power" package, and is poised to "address significant scientific questions relevant to stated NASA goals." DATA MANAGEMENT PLAN is not required because this proposal is for instrument development only.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Regents of the University of California	Supporting Organization	Academia	Oakland, California

Primary U.S. Work Locations	
California	Georgia
Texas	

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Haris Riris

Principal Investigator:

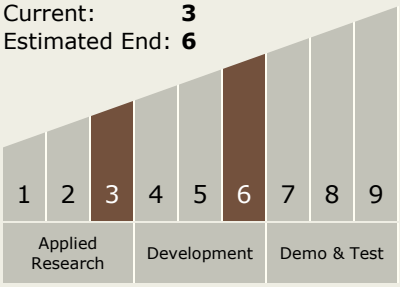
Richard A Mathies

Co-Investigators:

Amanda Stockton
Paul S Turin
Michael Ludlam
Jungkyu Kim
David M Weldon
Mark C Price
David W Curtis
Mark J Burchell
Anna L Butterworth

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **6**



Technology Areas

Primary:

- TX08 Sensors and Instruments

Continued on following page.

Technology Areas *(cont.)*

- TX08.3 In-Situ Instruments and Sensors
  - TX08.3.4 Environment Sensors

Target Destination

Others Inside the Solar System